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Time Series of Environmental Variables, Abundance, and Catch Data (1986-88) for Nehu (*Encrasicholina purpurea*) at Pearl Harbor, Oahu, Hawaii

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Abstract

Pearl Harbor, Hawaii, is a tropical island estuary supporting a population of tropical anchovies, nehu (*Encrasicholina purpurea*). Nehu is an important bait for the commercial pole-and-line skipjack tuna (*Katsuwonus pelamis*) fishery.

On average over 225 million gallons per day (mgd) of fresh water flows out of the 233 km^2 (90 mi^2) drainage basin of Pearl Harbor, with only 77 mgd actually exiting the estuary. With the possibility of losing West Loch (one-third of Pearl Harbor's most productive area) to an agriculture water plan that would essentially dam this productive estuarine habitat, an investigation was warranted to determine nehu's critical environmental needs.

The Pearl Harbor nehu population was studied weekly for 2 years, and cyclical variation in reproduction, abundance, and commercial catches was found. Seasonal variations in freshwater input (salinity), water temperature, wind speed/direction, and cloud cover contributed directly or indirectly (positively or negatively) to these cyclic events. Water temperature was the most influential stimuli of all the environmental variables measured on adult nehu. The spawning and commercial biomass estimates varied between 0.5 and 2.0 metric tons (t) and 0.5 to 20.0 t, respectively. With the continued expansion of the urban populations, and the evergrowing demand for fresh water, this estuary is a rapidly changing ecosystem in danger of losing its predominant driving element--the fresh water source.

INTRODUCTION

The endemic anchovy of the Hawaiian Islands, nehu (*Encrasicholina purpurea*) is the major bait source of the local skipjack tuna (*Katsuwonus pelamis*) pole-and-line fishery and inhabits estuarine areas throughout its life. Nehu occur only in particular estuarine areas in Hawaii (Tester 1955; Nakamura 1970; Clarke 1989b; Somerton et al. 1993) such as Kaneohe Bay and Pearl Harbor. Kaneohe Bay ranks first in bait production. Kaneohe Bay is a weakly developed estuarine system with components of both estuary and marine environment (coral reef) with moderate influences in the form of fresh water, sediment, and nutrients (Smith et al. 1981; Laws et al. 1993).

Pearl Harbor is second in importance only to Kaneohe Bay in area of estuarine habitat and nehu bait production. Pearl Harbor is a true coastal plain estuary (Cox and Gordon 1970) and a drowned river mouth complex located on the southern coast of Oahu, Hawaii. The main focus of this work was to examine the relationship between nehu and fresh water and the potential effects that water runoff diversion may have on the existing population at Pearl Harbor. An alteration of freshwater sources from recharge areas, the drainage basin, and orographic rainfall into the Pearl Harbor aquifer (Fig. 1) (Hunt et al. 1988) would divert fresh water from West Loch of the estuary for irrigation (Fig. 2, Fok and Murabayashi 1992). This interruption could alter bait production and have an effect on the pole-and-line tuna industry, since nehu production is considered to be one of the factors limiting this industry (HI Fish. Res. Plan 1990-1995, 1992).

A 2-year weekly time series investigation was initiated to study nehu and its habitat by sampling environmental and biological parameters and to relate nehu abundance and commercial catch to the biological and physical characteristics of the Pearl Harbor estuary.

MATERIAL AND METHODS

The three lochs and main channels of Pearl Harbor were divided into 39 spatial stations (Fig. 3). Stations were sampled weekly from April 3, 1986 to April 7, 1988. The sampling consisted of two distinct phases, one in the morning collecting plankton (eggs and larvae) and one in the afternoon beach seining for adults. Commercially caught nehu were sampled from live bait wells aboard the fishing vessels after regular bait-fishing operations were completed. The sampling details and production models are described in Somerton et al. (1993) and will not be reiterated here.

Weekly atmospheric data were obtained from the National Weather Service on rainfall, percent cloud cover, and wind velocity measured at the nearby Honolulu International Airport. The Honolulu Board of Water Supply and the Geodesic Survey maintained stream flow information at Waikele Stream as well as information on intrusion of artesian upwelling in Pearl Harbor.

All data collected in this paper were worked through a 5-week moving average. Station depth (m), volume of water sampled (m^3), and the mean and maximum levels of eggs, larvae, and adult nehu food items are shown in Appendix A.

RESULTS AND DISCUSSION

Environmental Variables

Water Temperature

Water temperature (Fig. 4) has previously been suggested as the main physical driving force of estuarine fish development (Cunjak et al. 1989, Deegan 1990, Clarke 1992, Davaine and Beall 1992). Temperate estuaries at higher latitudes have well-defined seasonal variations, whereas tropical estuaries are normally dominated by two seasons, wet versus dry (Day et al. 1989).

The annual range in water temperature for this study was approximately 6°C (>10°F) for Pearl Harbor. Maximum temperatures are reached during July-October with minima during November-March. Mean temperature measured for different positions in the water column, identified as upper (0-5 m), middle (5-10 m), and lower (10-bottom), illustrates dynamic changes in distinct layers (Fig. 4). Additionally, temperature data from Koko Head (southeast Oahu) are provided to compare coastal/oceanic sea surface temperature to Pearl Harbor. This plot illustrates an interesting process; surface (upper) waters in Pearl Harbor warm faster and reach higher maximum temperatures than the other strata because of the layering of the warmer, less dense water, but the cooling process between strata is more similar because of mixing of the cooler, denser water. Undoubtedly, the upper layer is influenced by solar radiation, and other climatological variables (e.g., winds), with the middle and lower strata being more influenced by the influx of oceanic water.

Salinity

Mean salinities (Fig. 5) for Pearl Harbor from August 1986 to April 1988 show seasonal and shorter period fluctuations with significant influx of fresh water during winter or rainy episodes. The greatest influences of cyclical freshwater influx are normally in November and December, but these cyclical events also occur as pulses of fresh water in January, February, and April (1987). With drier summer months, salinity steadily increases (to its highest level), until the winter rains resume. A combination of severe winter storms during 1987-88 caused 8 to 10 weeks of rainfall. This massive influx of fresh water is seen as a sharp decrease in salinity during this time period (Fig. 5). The seasonal trends return to a more normal cycle toward the end of study.

Mean salinity measurements for the 0-5 m (upper), 5-10 m (middle), 10 m bottom (lower) Pearl Harbor depth strata and for Koko Head are presented in Figure 5. Salinity in the surface to 5 m stratum fluctuates primarily in relation to freshwater discharge into the harbor. The middle and lower layers vary similarly in salinity, but the changes are independent of the upper layer. The middle and lower layers track each other and either do not resemble the upper reaches of the column or show a delayed effect. During some extreme events (Sept and Dec 1986; Mar-April, June and July 1987) an opposite effect occurs--middle and lower layer salinities seem reversed from surface effects or show a lag in changing salinity because of a time delay in fresh water reaching these lower layers.

Ship traffic in the estuary also significantly affects salinity layering. Jokiel and Evans (1974) found changes in salinity and temperature in heavy traffic areas near the main docks, resulting in complete mixing of layers where large ships or tugs brought bottom sediments to the surface. Routine disturbance caused by boat traffic undoubtedly affects circulation patterns.

Desylva (1985), on the other hand, reports salinity as the most important characteristic of an estuary. Kobayashi and Somerton (in prep.) found that reduced salinity levels appear to have a beneficial effect on the larval-juvenile survivorship of nehu in Pearl Harbor. This may be related to larval-juvenile food abundance, although the exact mechanism is unclear at present.

Waikele Stream Flow

Waikele Stream is one of six major perennial streams entering Pearl Harbor and the only one entering West Loch. Runoff entering Pearl Harbor is often siphoned off upstream from its upper drainage area for urban and agricultural use. Waikele's major flow peaks occur during the winter rainy season, with the exception of the June-July 1987 fluxes (Fig. 6). Peak flows are indicated by reduced salinities (Fig. 5, Geodesic survey 1988).

Cloud Cover

Percent cloud cover (Fig. 7) represents the percent of sky covered by clouds at the Honolulu International Airport. Lower percent cloud cover increases solar heating and affects circulation, evaporation, wind, and rainfall. Cloud cover peaks follow winter rainy season patterns except for the summer of 1986 and the winter of 1987-88. During the latter period a relatively long-term event--a series of northerly low-pressure storm systems--severely affected Oahu and the percent cloud cover.

Wind

Wind affects circulation, temperature, and mixing of the harbor. Figures 8 A-C illustrate mean wind speed (A), mean wind direction (B), and weekly wind vectors (C). Clarke (1992) found that certain wind speeds and direction had adversely affected nehu egg abundance in Kaneohe Bay, windward Oahu. Thus, an increase in egg abundance was seen with calm or southwesterly winds while egg abundance was reduced in seasons with strong northeast (NE) trades. For Pearl Harbor, wind effects might differ because of its leeward location and, to an extent, different combination of cloud cover and wind fetch angles. Wind direction was found by Kobayashi and Somerton (in prep.) to have a significant effect on larval-juvenile survivorship of nehu in Pearl Harbor; more northerly winds appear to enhance survivorship while more easterly winds have a negative effect. The exact reasons for this are unclear.

Zooplankton Abundance

Zooplankton abundance (Figs. 9A and 10) represent important prey for adults and late-stage juveniles (Hiatt 1951). The spatial pattern of overall mean zooplankton abundance is shown in Figure 9A. This zooplankton index primarily represents the abundance of meroplanktonic shrimp larvae and crab zoea that spend only a portion of their lives in the plankton (Day et al. 1989) before they settle out as benthic forms. Zooplankton abundance for Pearl Harbor appears closely correlated with water temperature, and temperature and plankton food supply can be key factors for regulation of zooplankton abundance (Yanez-Arancibia 1985; Day et al. 1989). The smaller peaks in zooplankton abundance in Figure 10 (October-November 1986) are possible results of earlier freshwater intrusion and an increase in associated nutrients. The larger peaks of zooplankton abundance may be more closely related to increases in temperature (Fig. 10 vs Fig. 4).

Egg Production

Figure 9B depicts the spatial pattern of overall mean egg abundance for each station, and Figure 11 summarizes overall egg production for the entire study. Apparently egg production, as zooplankton abundance, tracks water temperature (Clarke 1992, Imai and Tanaka 1987) but does not have a clear relationship to other environmental variables. Although patterns of water temperature and egg production generally appear similar, they do not always coincide. Studies on *Encrasicholina devisi* and *E. heterolobus* found a degree of correlation between spawning events and environmental variables, the most significant being moon phase and to a lesser extent, rainfall and temperature (Milton and Blaber 1991).

Low egg production was seen in the beginning of this study in April 1986 during the cooler winter months, then an increase to a summertime peak. Like water temperature, egg production cycled to a winter low and remained low until water temperatures increased. February and March 1987 showed a sharp peak in egg production despite the hypothesis that there should be a reduced egg abundance in the estuary during cooler winter months. We suggest the possibility that larger nehu immigrated into the estuary from an outside source; i.e., another harbor or perhaps the ocean. Clarke (1992) reports a similar experience in Kaneohe Bay in 1983 when a background population of smaller adult nehu were invaded by a population of larger fish (also present in commercial catches). The Kaneohe population eventually returned to its background population size. We are uncertain whether this same phenomenon occurred in Pearl Harbor, but examination of egg production trends (Fig. 11) shows some interesting production for a time of year when one would expect reduced abundance of eggs in the estuary. Mature nehu usually spawn every other night, hydrating their eggs in the late afternoon. Before sunset, all prespawning females have hydrated eggs (Somerton et al. 1993), and depending on the season (winter-summer), spawning is condensed into a 1-2 hour interval after sunset, with a longer period in summer (Clarke 1989a, 1989b). In the peak spawning summer months, which are associated with ideal environmental conditions, nehu may spawn every night. The incubation period for eggs is estimated between 22 and 35 hours and is temperature related (Clarke 1992). During November 1987 to the end of this study, egg production was erratic. This was possibly caused by the large influx of fresh water (Figs. 5 and 6) and increases in zooplankton production, along with an unexplained increase in spawners.

Larval Abundance

The spatial pattern of overall mean larval abundance is illustrated in Figure 9C, and seasonal patterns of larval abundance are shown in Figure 12. The greatest mortality occurs in the egg and larval stages, but there appear to be seasonal periods of increased survival for eggs and larvae (Clarke 1987, Somerton et al. 1993, Somerton and Kobayashi in prep.).

Growth also varies seasonally and is usually related to water temperature (Imai and Tanaka 1987). Summers and Rose

(1987), Peebles and Tolley (1988), Clarke (1989a, b), and Davaine and Beall (1992) observed the fastest growth for larval fishes occurs at the warmest temperatures. For nehu, however, summer larvae did not exceed or equal the size of winter larvae until approximately 7 days (Somerton and Kobayashi, in prep.) because of the initial growth rate and smaller initial size. In our study, larval abundance began low in April 1986 (Fig. 13). Eggs are generally larger (25% and 30% respectively, Clarke 1989) in December and March, and nehu larvae weights are heavier during winter. Positive egg size to size-at-hatch relations have been noted in other fishes, (e.g., herring; Hempel and Blaxter 1967). Adult female nehu put more energy into larger winter eggs, but were described by Clarke (1987) as less fecund (having fewer eggs) in winter than at other times of the year, resulting in a reduction in overall larval abundance. Figure 12 represents larval abundance at several ages and is a series of cohorts from multiple spawnings.

Recruitment

Larval abundance is followed by recruitment into the fishery. Recruitment, in this context, occurs when the fish are available to the commercial fleet nets, usually around 10 weeks (Fig. 13). This standard is used to demonstrate the average age and size of the nehu that recruit into the fishery (Kobayashi and Somerton in prep.). In Figure 13, the prime peaks and valleys reflect summer maxima and winter minima. Peaks could possibly fluctuate with cohort success and varying growth rates over the season. Possible immigrations (unsubstantiated) may affect these results. The large peak (March-April 1987) could be caused by the immigrant cohort success. This combination of environmental variables may not have direct effects on Pearl Harbor nehu, but they may have positive relationships to it (e.g., Summers and Rose 1987). Figures 12 and 13 share several similarities with regard to changes over time.

Juveniles go through a final change in feeding regimes before entering the adult populations (Hiatt 1951, Burdick 1969, and Clarke 1989 A and B). Diel feeding patterns change through larval and juvenile stages. Once the yolk sack is absorbed, larvae feed primarily during the day up to a size of approximately 20 mm. Feeding both day and night occurs until juveniles reach approximately 25 mm, when they feed at night. However, adults were observed to occasionally opportunistically feed in stream mouths and dredge plumes during the day (pers. observ.).

Female Weight

Female body weight (body size) was the most important biological parameter because of its influence on total egg production (number of eggs produced). Obtaining relative fecundities and spawning fractions, which is critical information for stock size estimation, depended on the somatic body weights of female nehu. Figure 14 represents the fluctuations of female weights during this study; female body weight seems to show a seasonal pattern. Variation in female weight changed from lows in the beginning of the study to large peaks in the middle to late stages. These are indications of large variations from sources such as food availability (condition or robustness) and immigration (length and age of fish).

Figure 15 is the cyclical variation in the proportion of females with ovaries undergoing hydration, which is the numeric proportion of the mature female population hydrating eggs. Figure 16 shows the eggs per gram of female body weight, or relative fecundity. The number of eggs hydrated per female, also called absolute or batch fecundity, is highly correlated to the weight of the mature female fish. DeMartini (1991), Hirshfield (1977), and Hunter and Leong (1981) suggest that larger (older) females have relatively, as well as absolutely, larger reproductive investments.

The Egg Production Method (EPM) (Somerton et al. 1993) yields biomass (B) from total egg production (P), relative fecundity (F), and spawning fraction (R). P and F are as described in the previous section. R is the total weight of spawning (hydrated) females divided by the total weight of all fish. This total could be just mature fish or all of harvestable fish (including immatures) to give either estimates of spawning or commercial biomass.

Commercial Data

Fishery

Presently the live bait pole-and-line skipjack fishery consists of 9 boats, only a few of which opt to purchase the expensive insurance allowed to enter Pearl Harbor (1986 = 5, 1987 = 4, 1988 = 2). The vessels date back to post-World War II era and are declining. Wooden-hulled aku boats are of sampan (Japanese) design averaging 58 t, with six 2000-5000 L live bait wells (Clarke 1989b, Boggs and Kikkawa 1993).

During the study, the commercial fleets collected a total of 5,358 buckets (3,494 in East Loch, 1,709 in Middle Loch and 155 in West Loch), while the authors collected 162 scientific adult samples (ca. 1 L) by beach seine in Pearl Harbor (45 in East Loch, 100 in Middle Loch and 17 in West Loch). Security restraints prevent commercial boats from operating in West Loch 100% of the time, and access to all shorelines in all lochs is limited. Figure 17 indicates the location of nehu captured, which combines catches from the present study with commercial fleet collections in the three lochs of Pearl Harbor as well as migration routes for late-stage juveniles and adults (between day and night habitats). Depending on the average size of the bucket

(23 L-capacity stainless steel bucket averages between 3-24 kg of live bait) (Uchida 1977), in this study it equals to 6.4 kg, approximately 34,300 kg (76,100 lb), or over 34 t of nehu caught (data from Fishery Management Research Program, NMFS). The Somerton et al. (1993) EPM estimates of weekly commercial biomass (the weight of nehu in t available as bait for the commercial fleet) coupled with estimated spawning biomass are shown in Figure 18. Seasonal variation and commercial fishing pressure account for commercial biomass estimates from lows of less than 1 t (weekly) to over 20 t of nehu available to the fishery. Figure 19A illustrates a weekly time series of catch and effort for the commercial fleet; catch-per-unit of fishing effort (CPUE) is shown in Figure 19B. The total spawning biomass averages approximately 45%, of total harvestable nehu biomass at 10 weeks and older. The spawning biomass appears to closely track total exploitable biomass. Nehu landings by commercial vessels averaged 51 buckets (327 kg) a week over the study period, and at this rate overfishing is not a problem. The availability of bait may seasonally limit the fishing fleet but have little effect on the actual biomass. Nehu landings could be expanded if it were not for security reasons in Pearl Harbor and seasonal shortages of bait (Figs. 18, 19 A and B). The total area of Pearl Harbor is <10^2 kilometers and less than half the shore line is available to the fleet, so summertime lows in bait put a strain on the fleet's ability to obtain sufficient bait (Fig. 18). Exploiting the Pearl Harbor bait resource further in a declining industry seems insignificant. In addition, the aging skipjack fishing fleet appears not to be increasing, and the issue of increased bait harvest is improbable. The fishery itself is in decline, with bait harvest and tuna CPUE falling (Boggs and Kikkawa, 1993). Bait production is obviously declining because fewer boats are in the fleet.

CONCLUSION

Environmental cues to small pelagic fish stocks, which traditionally do not fit well to conventional models of population dynamics, usually cover temperate, slow-growing species and make assessment difficult and uncertain (Csirke 1988). Environmental cues, except for the strongest, would be difficult to apply to most small pelagics and such efforts primarily focus on adult reproductive biology.

Water temperature alone was not the cause or effect of nehu variation. Temperature generally "sets the timing of reproduction" (Levinton 1982). As stated earlier, for egg production, Clarke (1992) found positive relationships to water temperature and negative relationships to wind speed. Although inconclusive, research by Kobayashi and Somerton (unpubl. data) found negative relationships in egg production to water temperature, salinity, wind speed, and cloud cover in Pearl

Harbor. Positive relationships were found to water temperature in female spawning fraction (% of females spawning) and female relative fecundity. Negative relationships exist for female spawning fraction to wind speed. As for larval and juvenile survival, Kobayashi and Somerton (in prep.) also found positive relationships with salinity and wind in that increased salinity may decrease food supplies, while reduced salinity (freshwater runoff) may increase food supplies and survival. Wind direction (fetch angles and its effects on water circulation) had differing effects, with northerly winds positively affecting survival and easterly winds negatively affecting it. Possible egg dispersion differences may exist between calm and windy conditions.

Inconclusive evidence exists for many of the remaining variables mentioned above. Zooplankton abundance related well to larval abundance and indicated a similar seasonal pattern to water temperature.

Definitive answers on the combination of environmental variables are inconclusive and elusive. Nehu and its young are fundamentally adapted to tolerate the environmental extremes of the estuary. Changes in the environment and the variability of nehu make it hard to pinpoint cause and effect.

Future work should examine the importance of nutrients, primary production, and microzooplankton to nehu population dynamics, as well as examining otolith increment width or RNA-DNA content as indicators of environmental change in nehu. In addition, research on the life history of the congener *Encrasicholina punctifer* may shed some light on the immigrant relationship in this study. *E. punctifer* is an oceanic nehu, widespread in the Indo-Pacific, and a close relative of *E. purpurea*.

Finally, in obtaining the additional environmental variables mentioned above, one would be able to understand Pearl Harbor and its effects on nehu biology as well as how it operates as an estuary.

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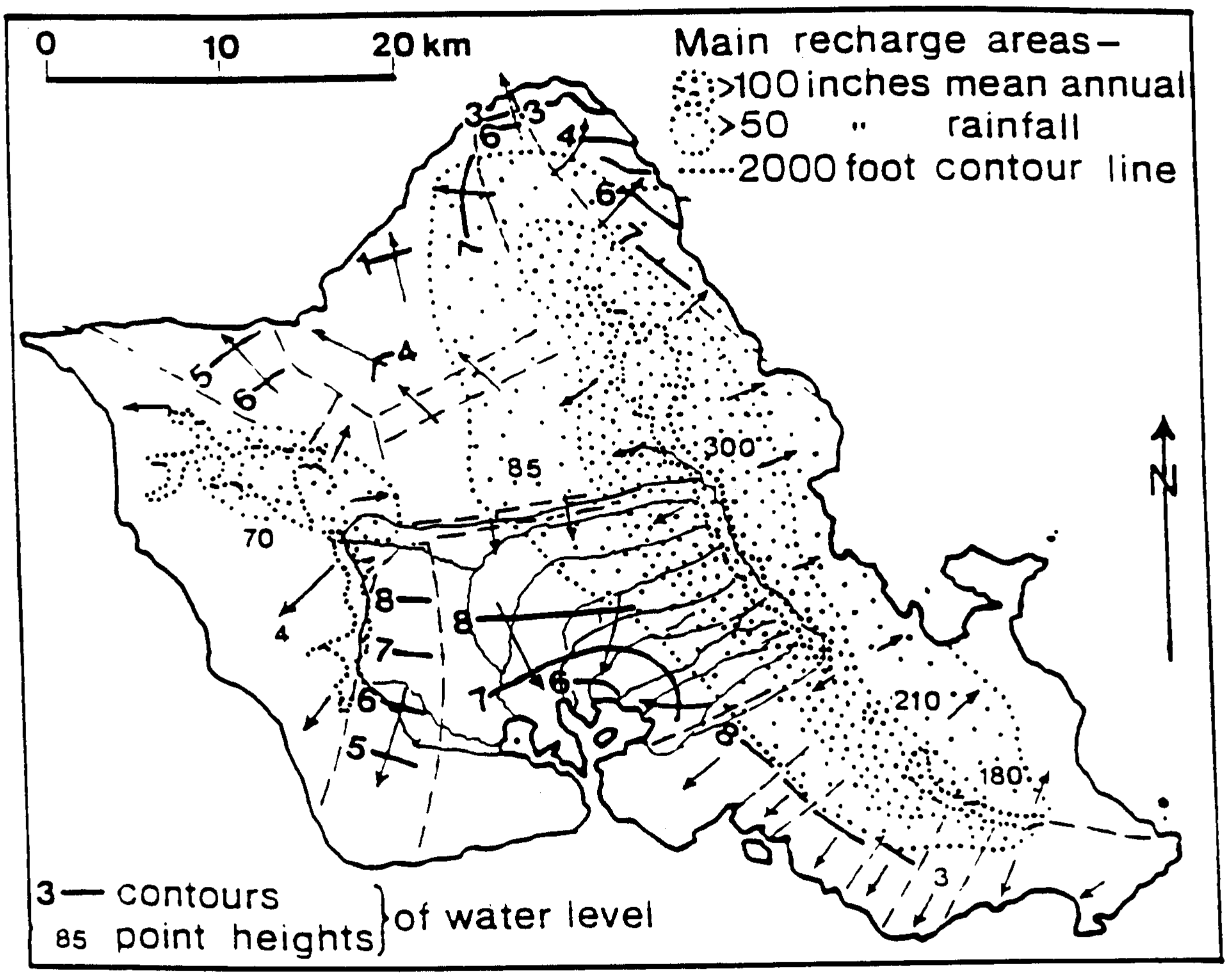


Figure 1.--Map of Oahu illustrating the drainage basin for the Pearl Harbor estuary and orographic rainfall with recharge sources.

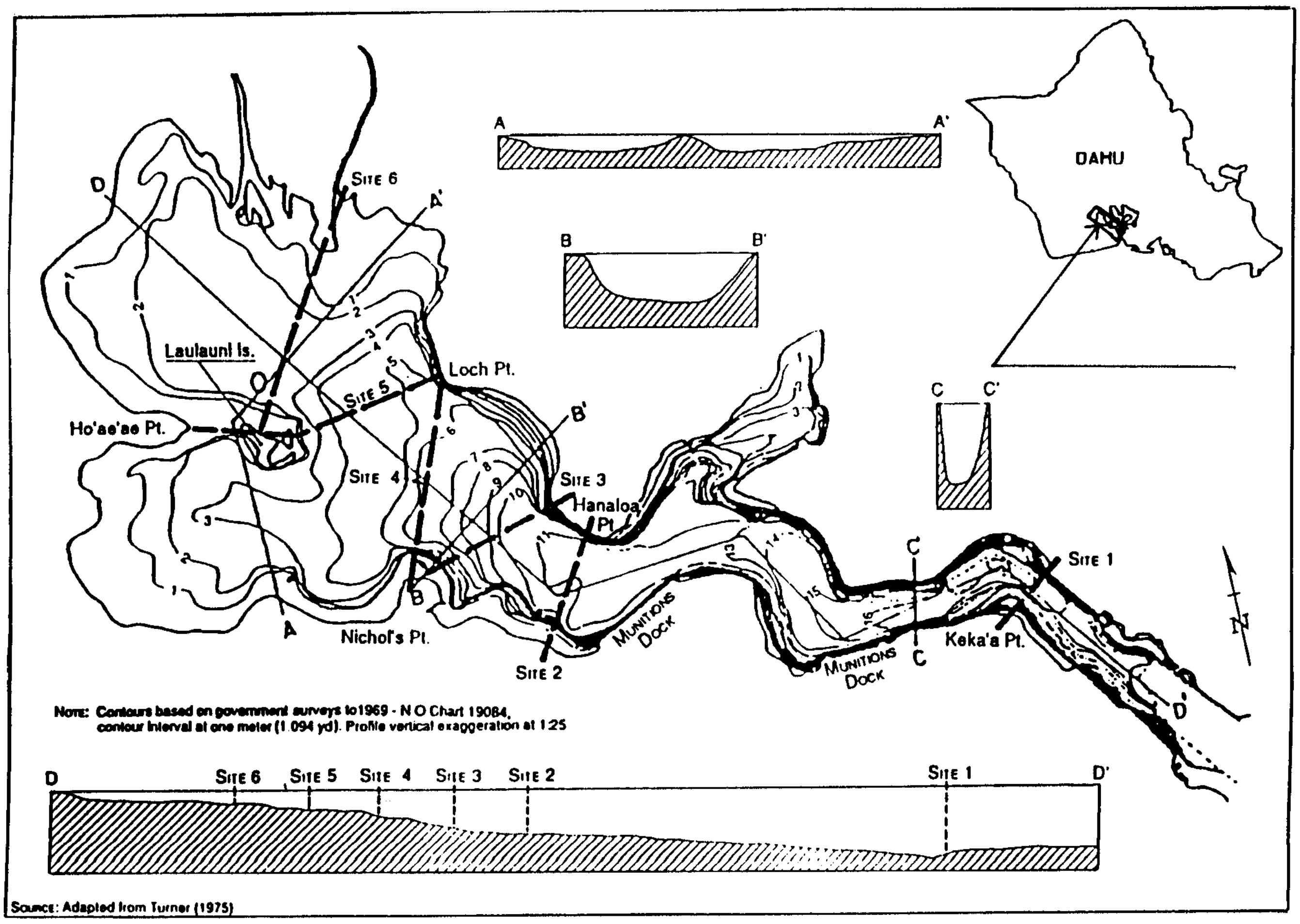


Figure 2.--Contour map of West Loch, Pearl Harbor with possible dam sites.

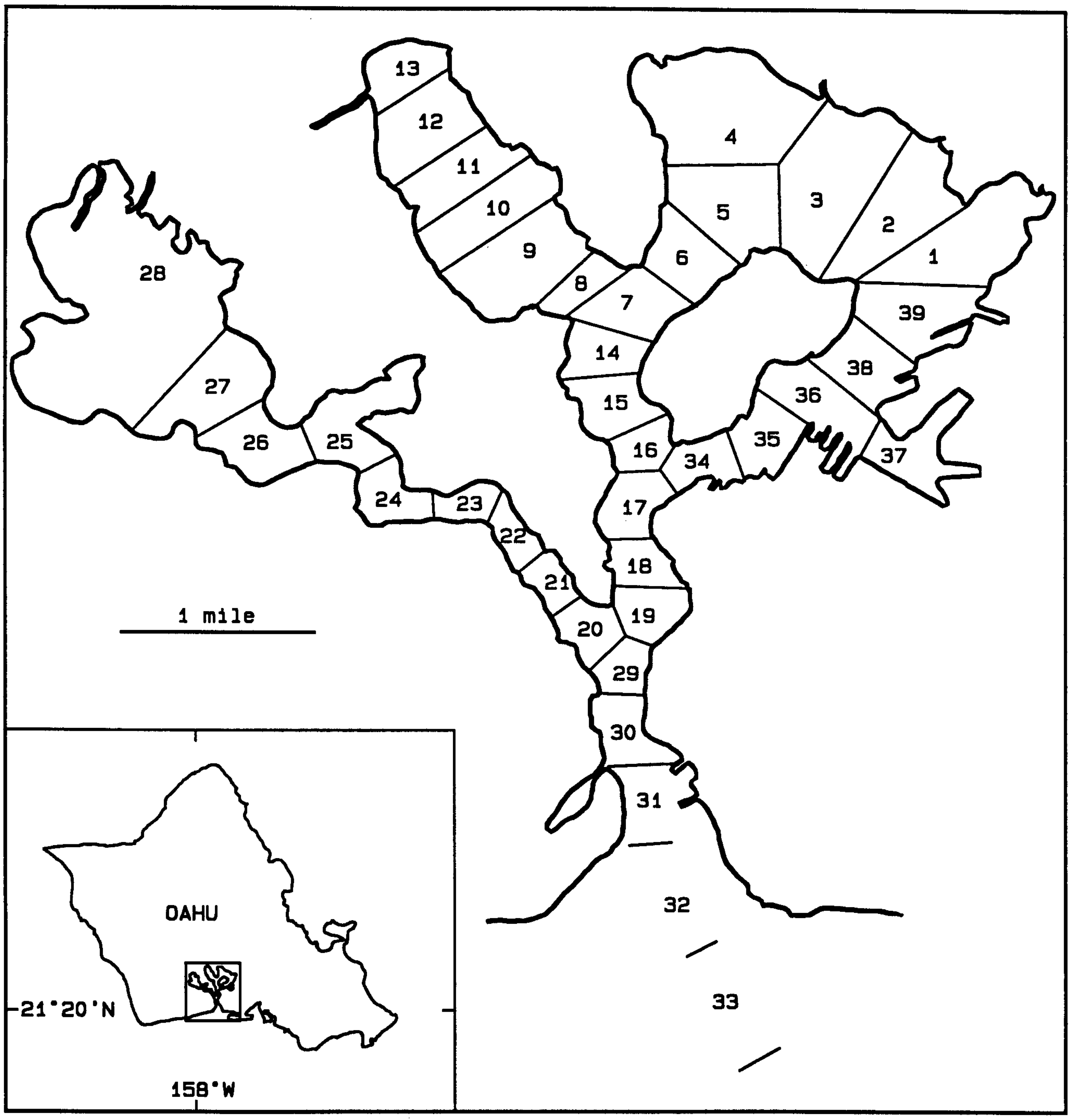


Figure 3.--Map and sampling stations in the Pearl Harbor estuary.

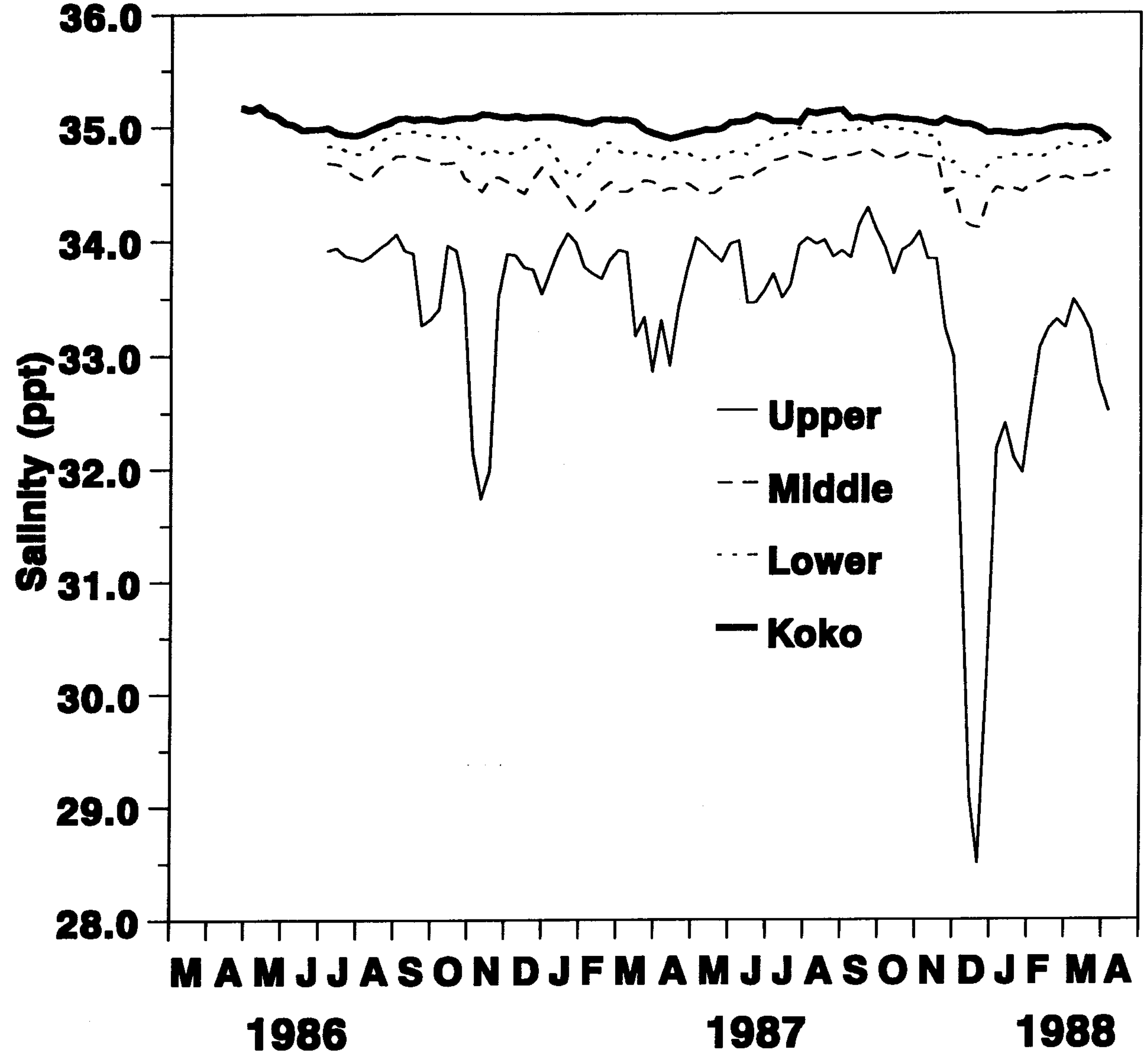


Figure 5.--Time series strata plot of mean salinities (parts per thousand) of depth in Pearl Harbor. Upper = surface to 5 m, middle = 5-10 m, lower = 10 to bottom. Koko Head salinity measurements are from the surface.

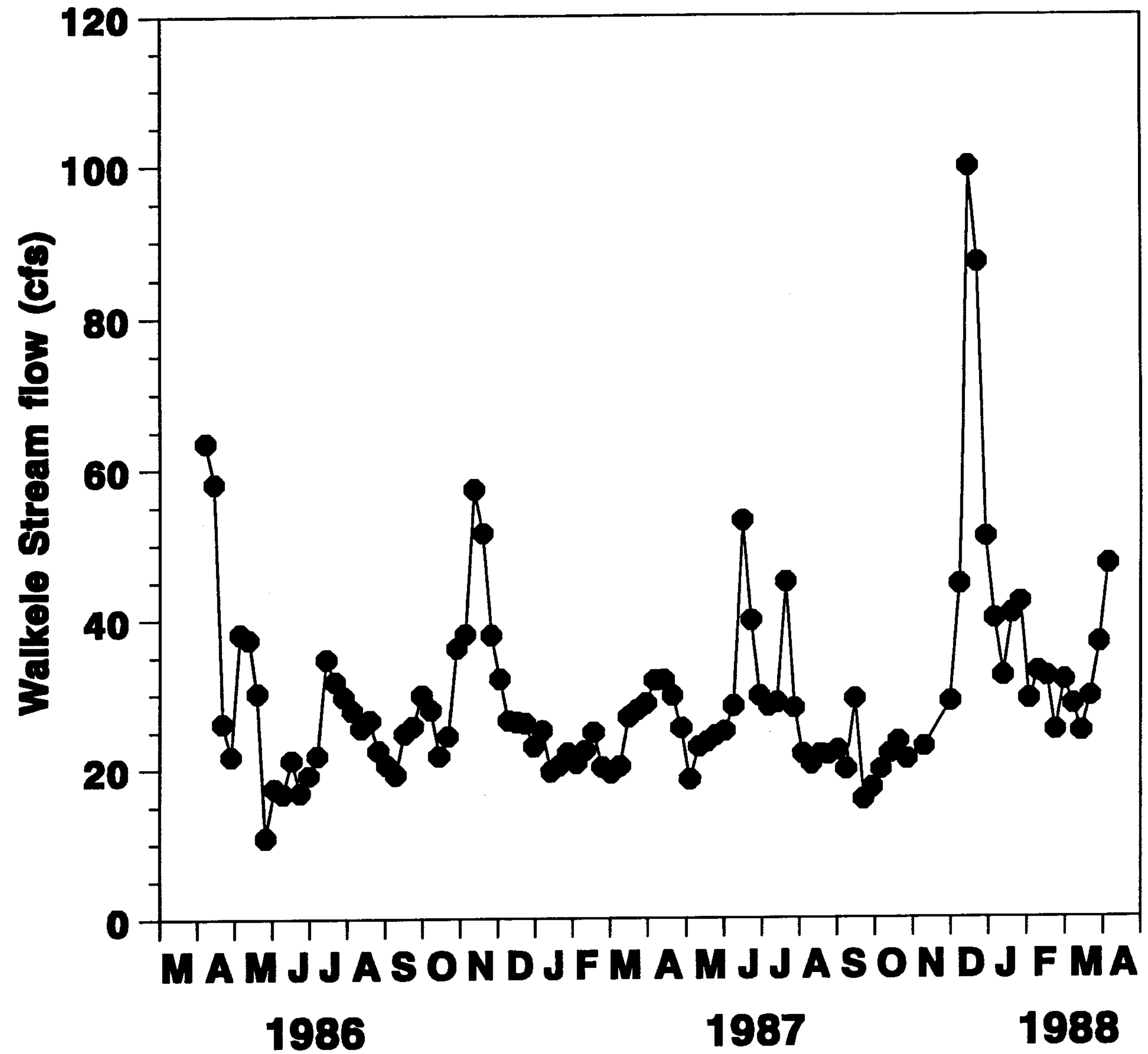


Figure 6.--Time series plot of Waikele stream flow in cubic feet per second from April, 1986-88.

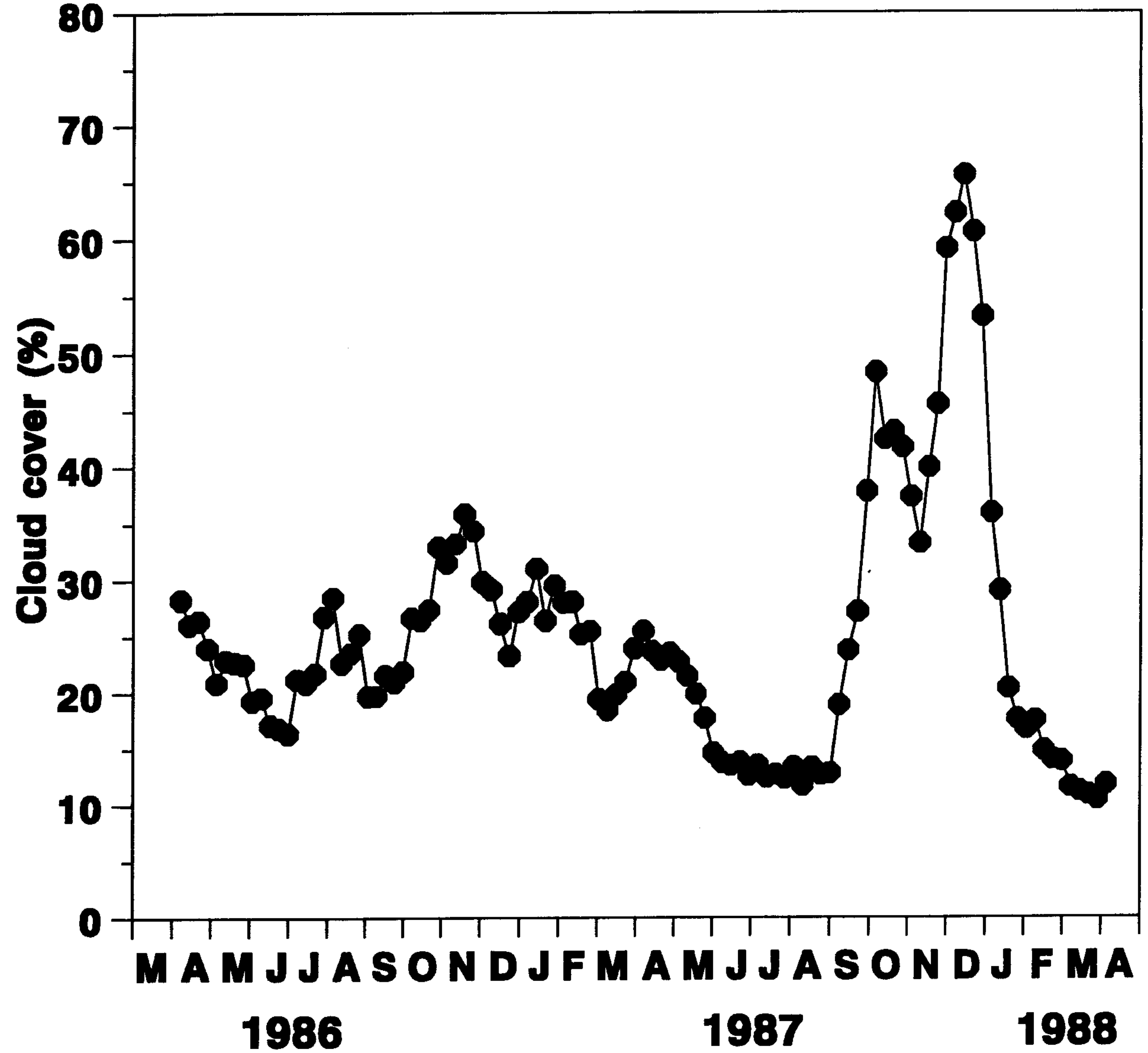


Figure 7.--Time series plot (April 1986 to April 1988) of mean percent cloud cover over Honolulu International Airport, which closely resembles cloud cover over the Pearl Harbor estuary.

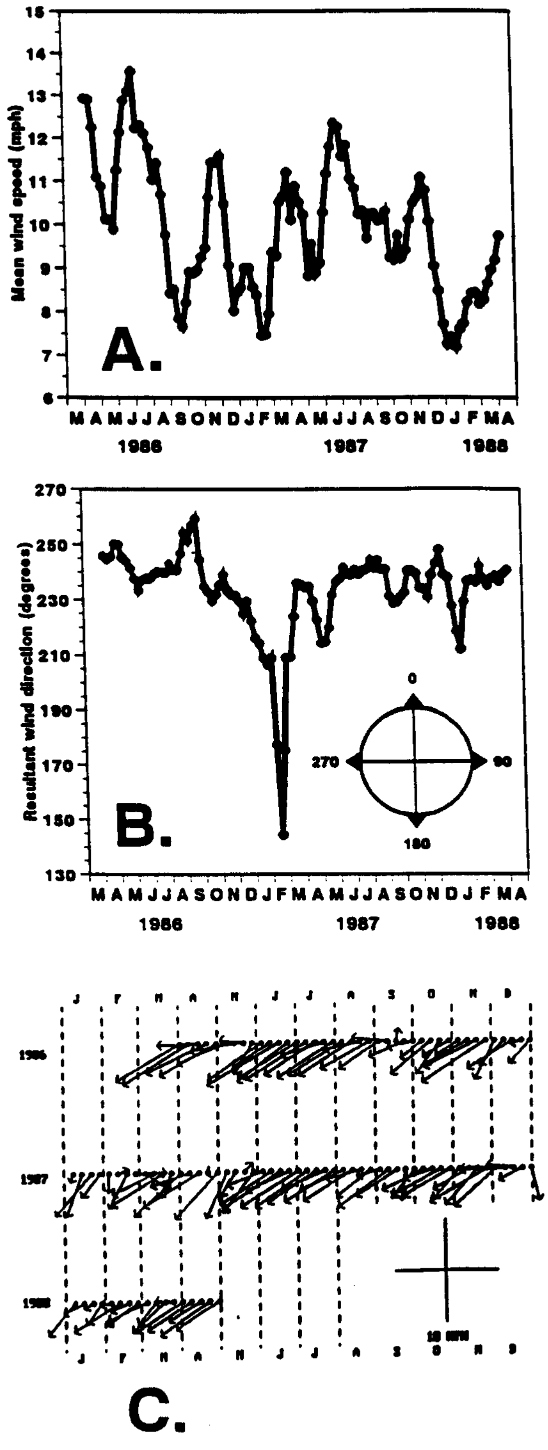


Figure 8.--Time series plot of (A) mean wind speed (miles per hour), (B) mean resultant wind direction (degrees), and (C) weekly mean wind vectors.

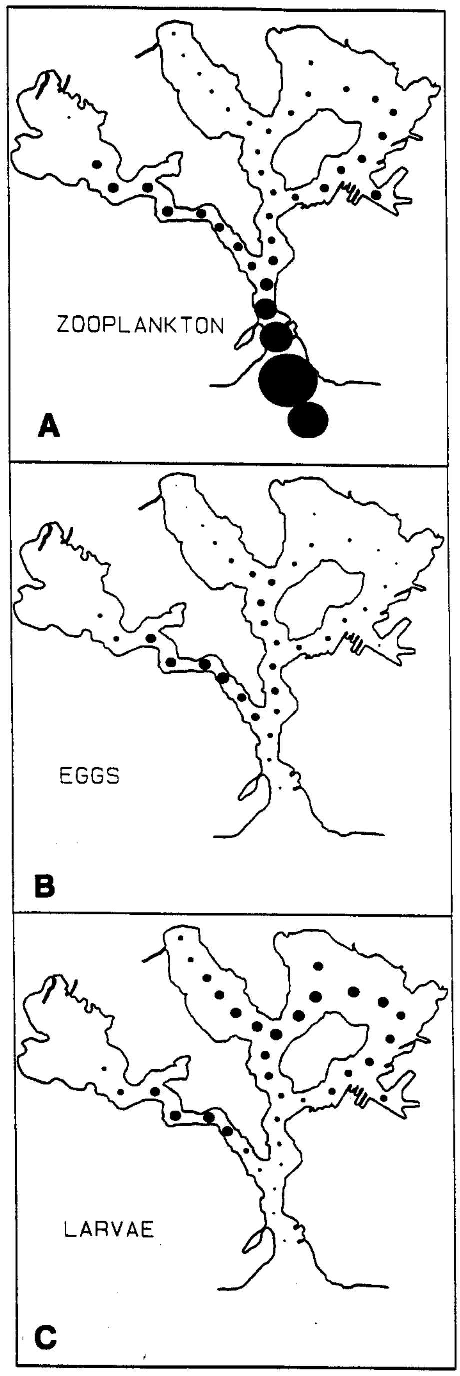


Figure 9.--Spatial pattern of overall mean abundance by station of (A) zooplankton, (B) eggs, and (C) larvae.

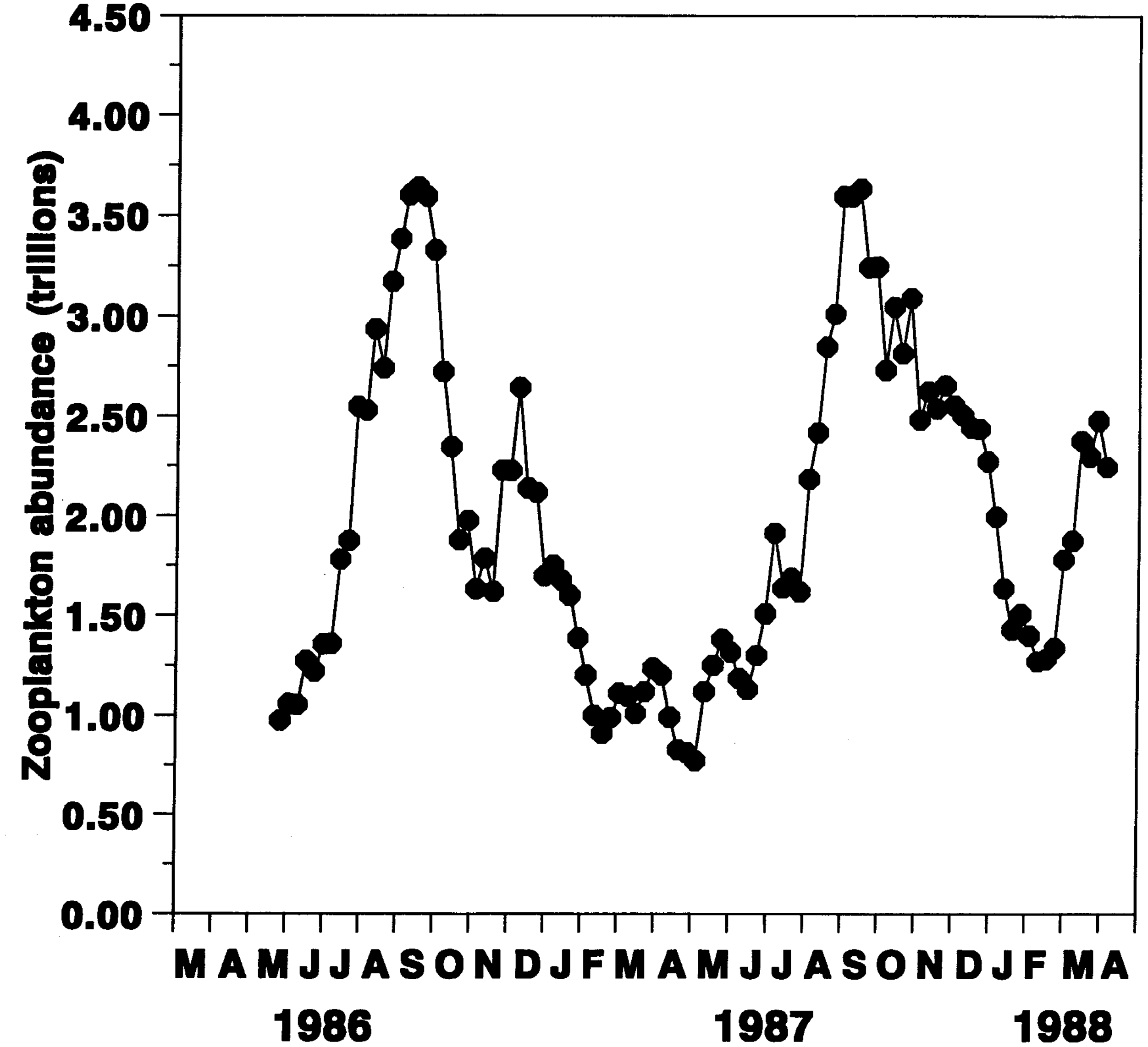


Figure 10.--Weekly time series of zooplankton prey abundance (trillions).

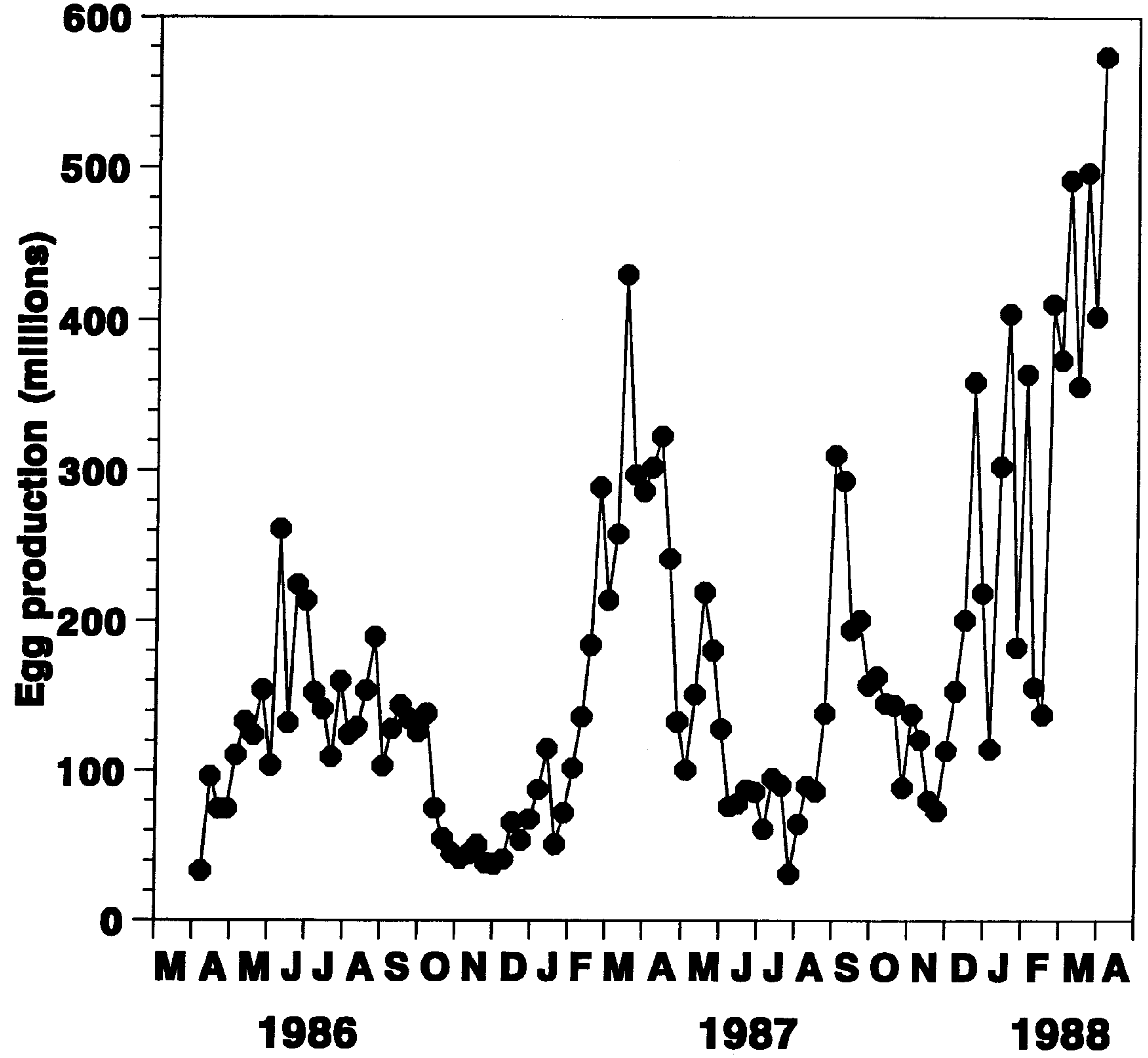


Figure 11.--Weekly estimate of daily egg production (millions).

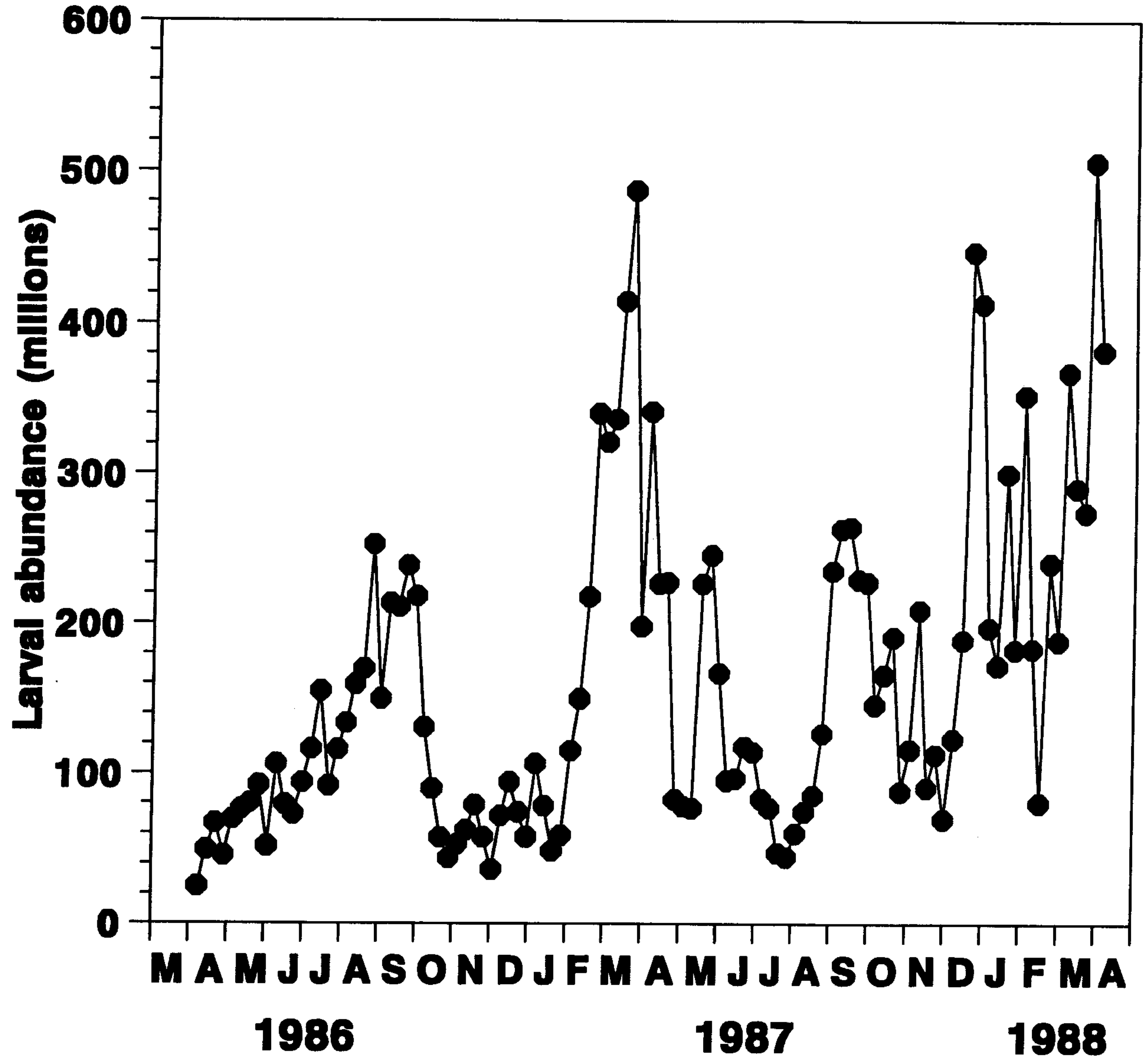


Figure 12.--Weekly estimate of larval abundance (millions).

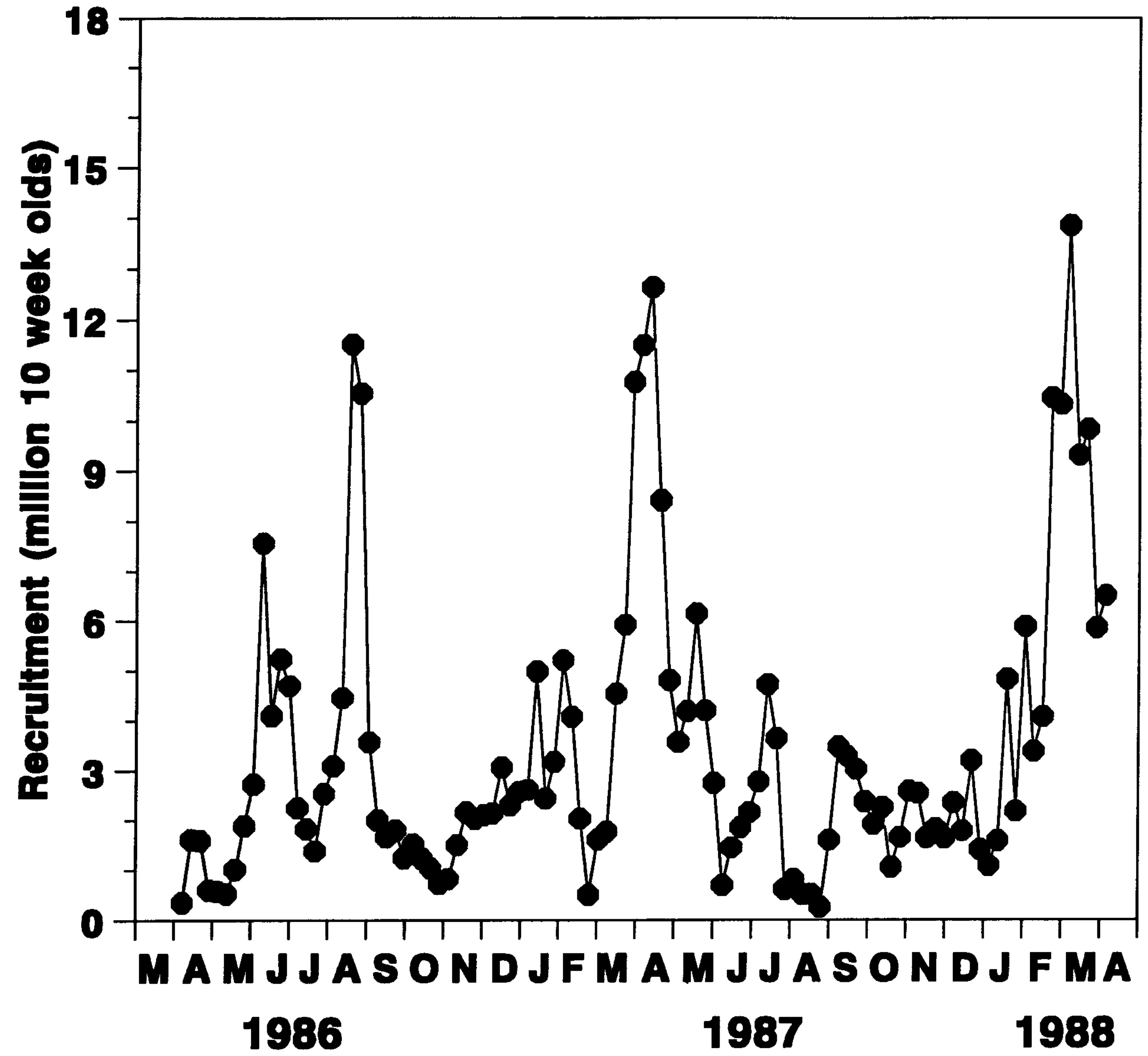


Figure 13.--Weekly estimate of recruitment into the fishery.

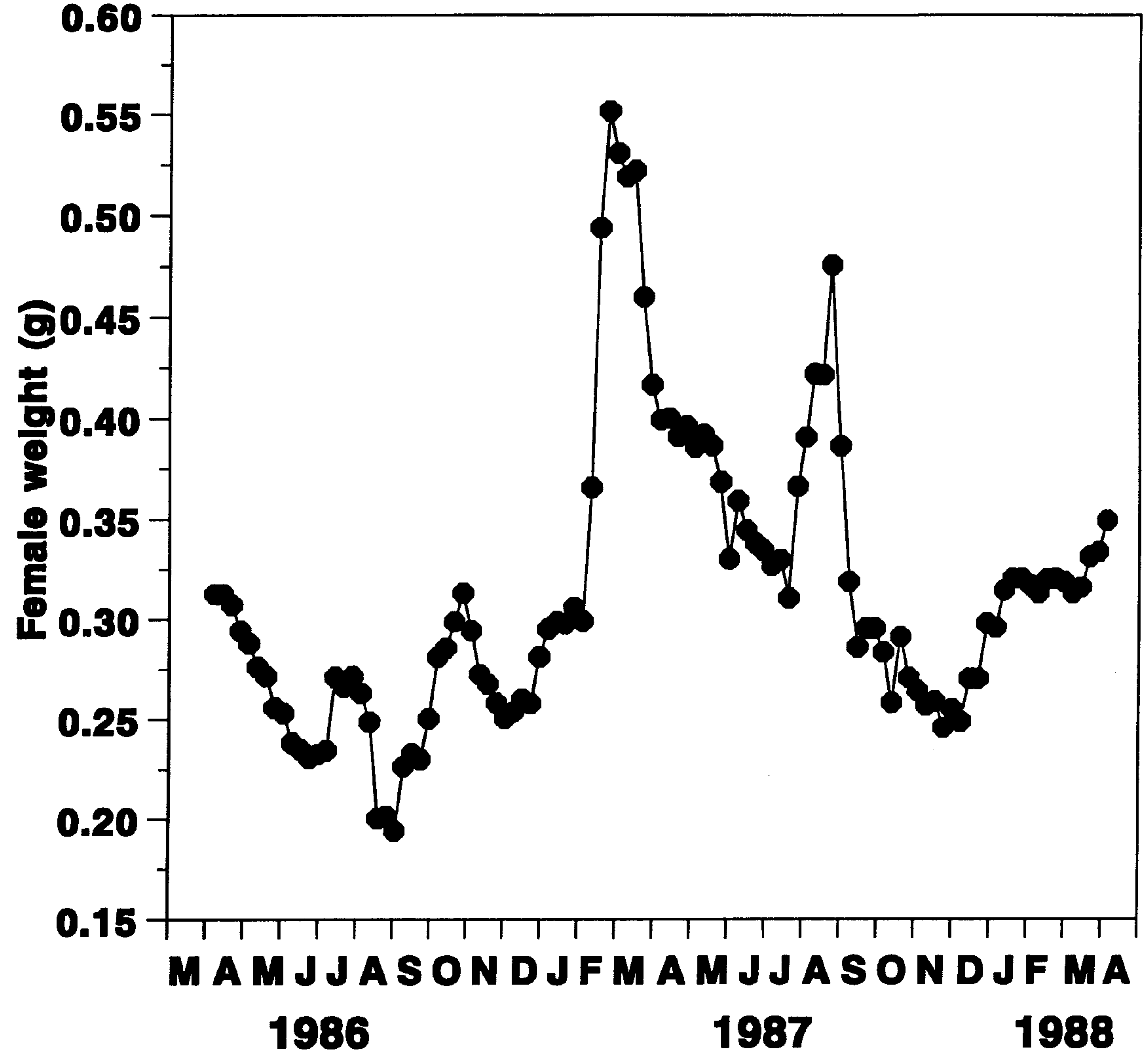


Figure 14.--Weekly estimate of female weight (grams) fluctuations during this study.

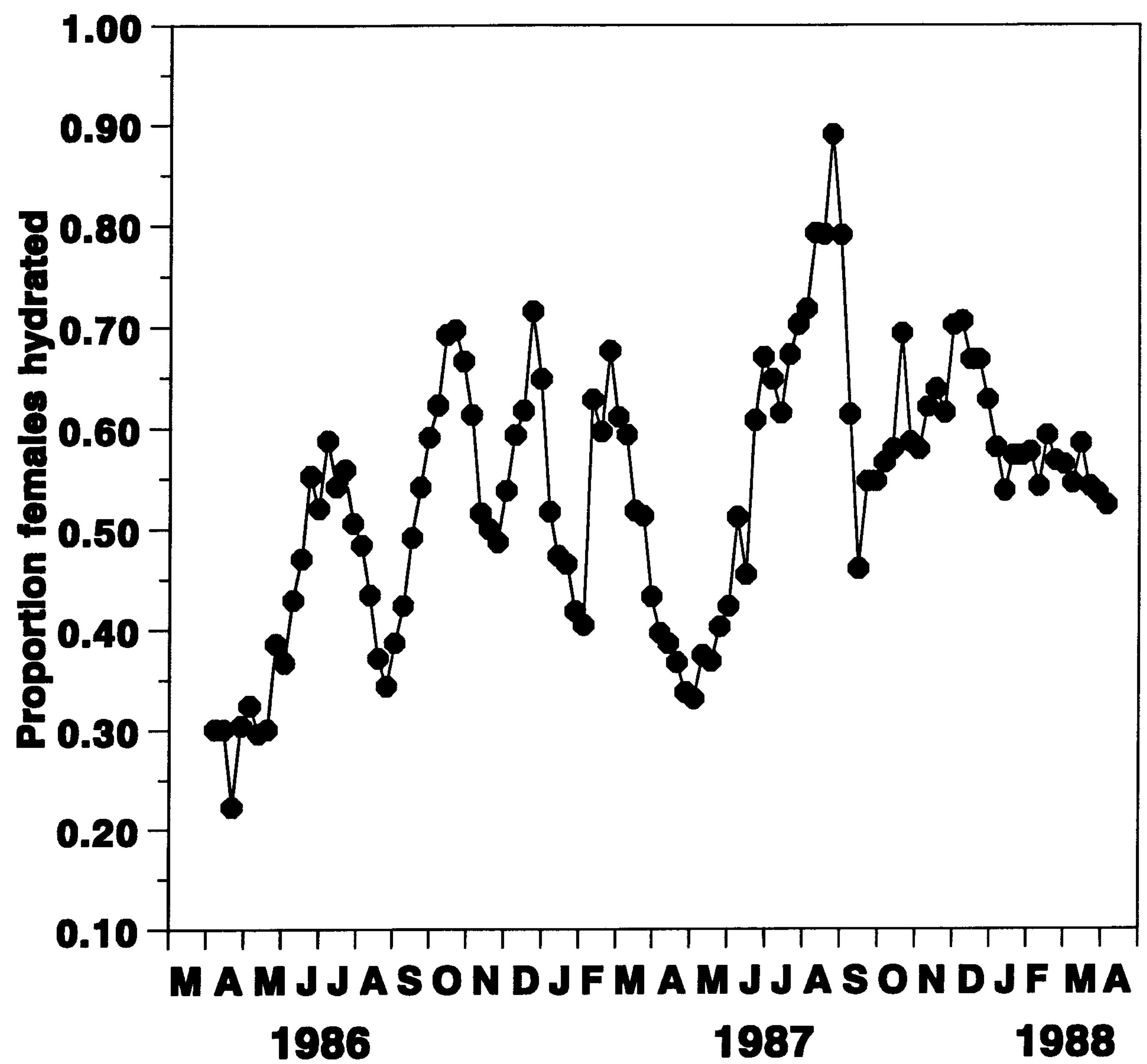


Figure 15.--Weekly variation in proportion of hydrated females in the estuary.

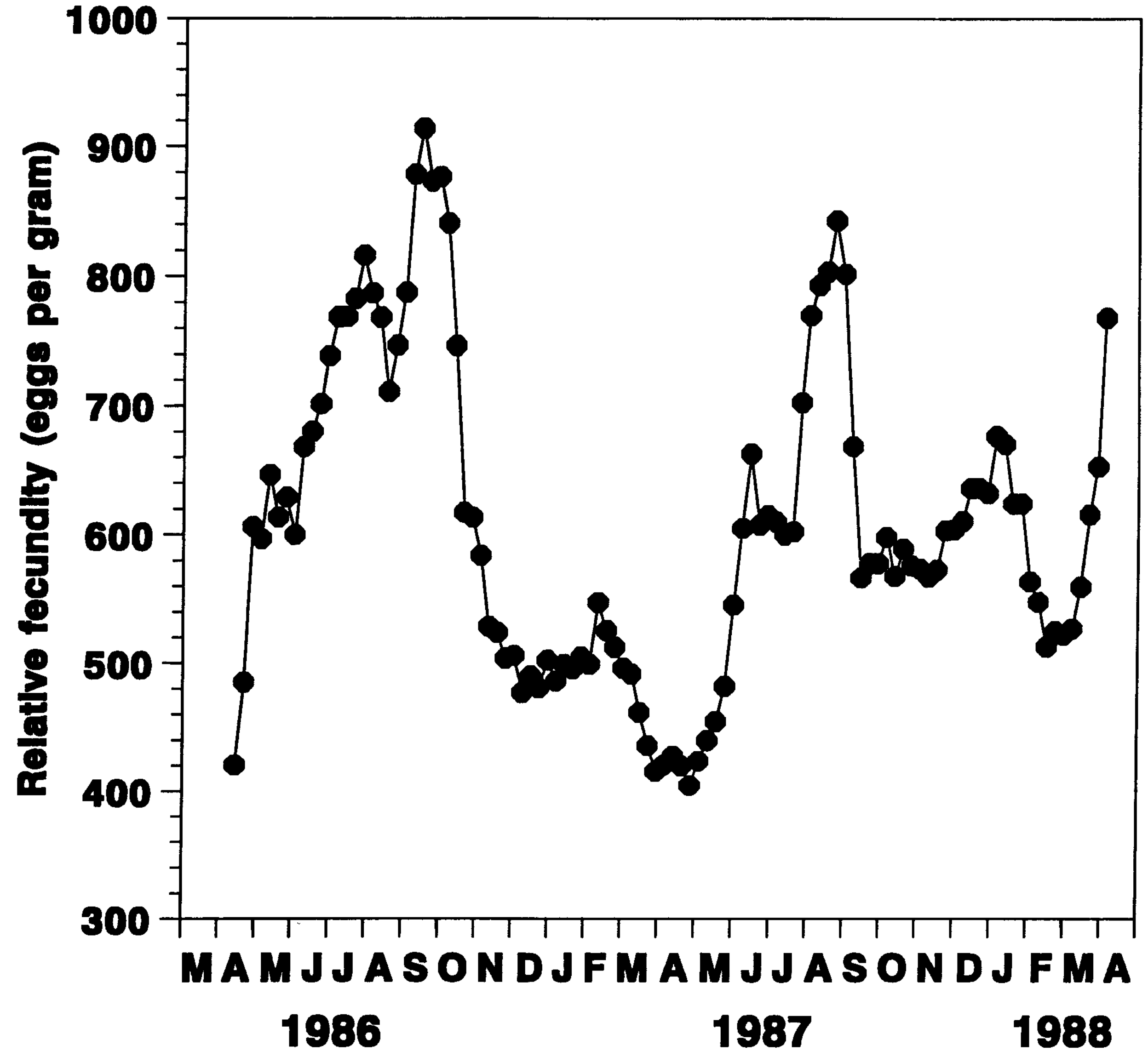


Figure 16.--Weekly estimate of relative fecundity, eggs per gram of female body weight.

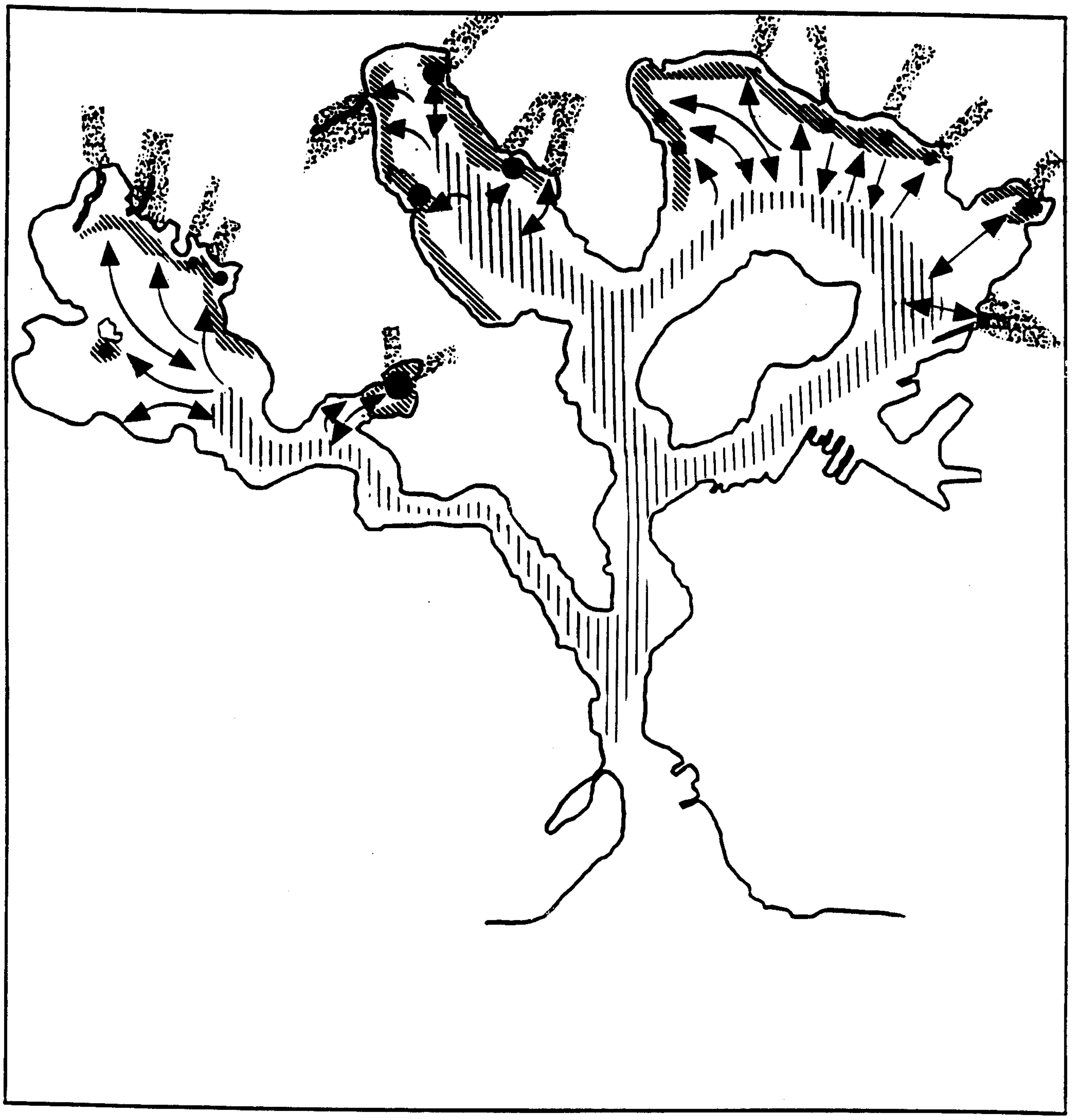


Figure 17.--Commercial and scientific collection sites for nehu (●). Diel migration patterns for nehu daytime habitat in shallow, turbid, low salinity areas (▧), migration to and from spawning or feeding areas (↑), feeding and spawning area (|||||), and freshwater intrusion (▩).

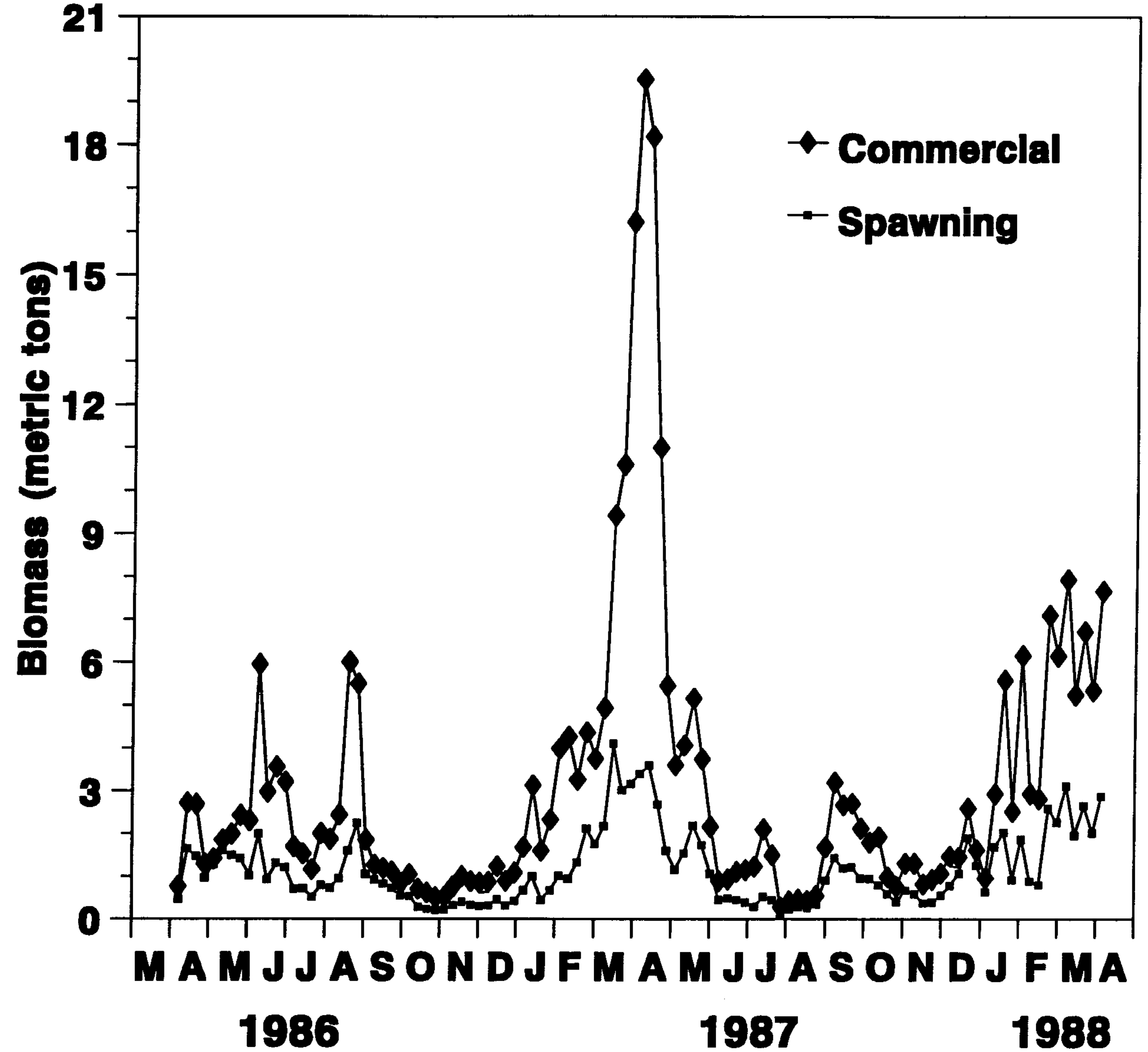
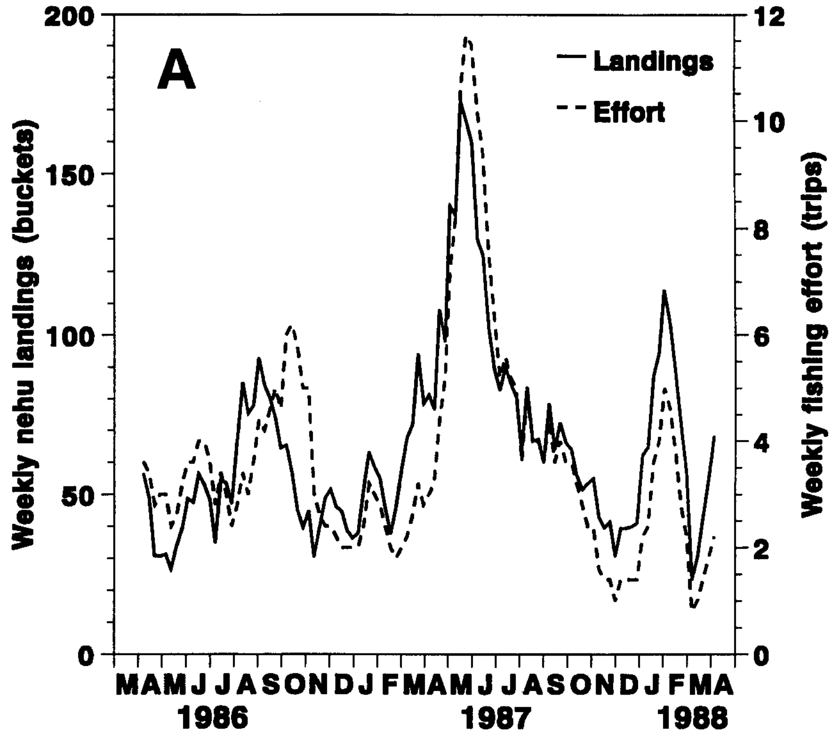


Figure 18.--Weekly biomass estimates of commercial and spawning stocks of nehu.



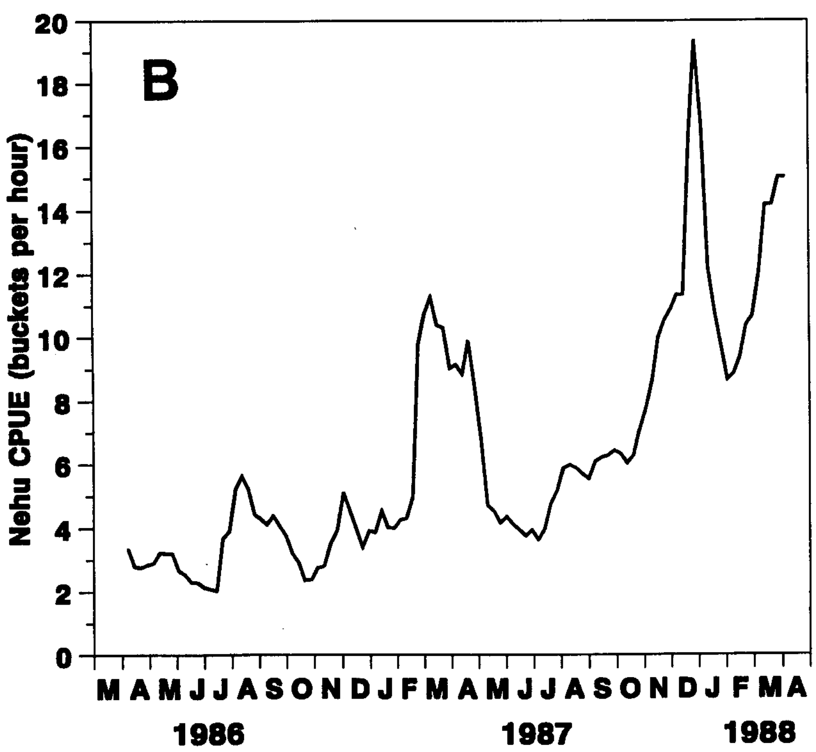


Figure 19.--Weekly nehu landings and effort (A) landings in buckets by weekly effort in trips, (B) nehu catch-per-unit effort (CPUE) in buckets per hour.

Appendix 1.--Mean-maximum plankton stats over time series, 1986-1988.*

STA	DEPTH		EGGS		LARVAE (Combined)		COPEPODS		ZOOPLANKTON (Other)	
(#)	(m)	Vol. m^3	Mean	Max	Mean	Max	Mean	Max	Mean	Max
1	13	6143812	4.02	67	11.21	67	15.90	543	137.96	530
2	13	6871100	4.53	78	14.39	77	11.78	160	120.12	340
3	13	8619986	7.97	105	15.84	65	16.91	636	109.07	333
4	11	6193349	4.34	88	12.52	61	12.86	749	79.24	210
5	13	6849503	10.38	56	15.87	57	13.43	381	93.63	333
6	13	4718032	11.53	58	15.66	60	21.18	905	98.74	348
7	13	4114158	17.29	120	15.45	60	18.10	361	95.53	255
8	13	2765341	15.28	70	14.59	54	21.11	727	82.13	231
9	13	6365101	11.68	77	14.48	63	15.31	348	70.74	201
10	11	3963319	8.16	49	12.17	63	10.43	408	58.33	142
11	11	3286767	5.11	51	11.10	50	4.10	23	59.53	174
12	7	3615187	1.58	48	6.61	46	3.52	80	44.04	123
13	7	1725403	0.80	14	6.15	61	3.27	62	47.70	173
14	13	3491430	16.97	131	10.61	42	16.60	123	77.82	278
15	13	3018169	15.89	92	9.81	56	27.26	778	87.82	265
16	13	2220946	12.90	51	7.13	60	42.76	1509	98.13	318
17	14	3196435	15.19	78	5.66	63	42.94	558	118.62	397
18	13	3025883	17.48	296	4.26	42	71.58	1048	129.28	705
19	13	3242715	13.57	138	3.11	49	111.82	1517	173.69	1776
20	13	2115873	19.86	331	3.70	25	80.73	1291	154.00	686
21	13	2044224	21.45	162	6.27	49	64.13	961	161.54	803
22	15	2008571	29.63	229	13.53	83	38.25	1033	167.14	755
23	15	2183408	29.36	122	14.80	88	48.29	1629	183.84	1022
24	14	3270483	25.44	139	14.34	70	47.17	1178	202.93	1248
25	11	3365101	24.76	215	12.12	68	22.28	489	194.44	1036
26	12	3945835	12.77	103	7.50	50	69.77	4329	195.60	2688
27	8	3524854	10.12	92	5.41	27	27.41	354	174.41	3684
28	2	5894755	0.92	26	0.63	10	2.31	32	40.59	282
29	14	2138670	11.06	114	2.24	17	201.83	2016	237.92	1632
30	14	3582277	6.77	75	1.61	13	306.95	2040	418.40	4384
31	13	4793966	4.00	47	1.25	13	531.61	2688	624.42	2656
32	14	4528283	1.49	22	0.50	5	1391.71	5504	1122.22	7680
33	16	5980802	0.13	1	0.38	5	2140.96	15424	760.54	2048
34	14	2486459	13.83	75	5.95	31	38.23	1170	128.80	453
35	14	3820021	12.52	48	8.40	46	24.01	566	150.91	695
36	13	5949263	11.10	55	9.28	58	22.04	728	149.73	641
37	12	5244086	3.44	33	9.03	44	15.82	817	189.71	635
38	13	5004114	9.94	44	11.04	45	23.13	900	151.26	500
39	13	6010799	7.00	59	11.58	56	13.44	159	148.84	576

* Minimum equals 0 or 1.